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affecting visual estimation of the separation of points and the length of lines. Besides this immediate object the author explains the aim of his experiments to be the examination of how far eye movements, or rather variations in the intensity of the sensations accompanying them, are responsible for visual judgments, all this forming part of a plan for demonstrating that the comparison of sensations, etc., (generally conceived to be an act of consciousness as opposed to a content of consciousness,) is in reality itself a content and not an act. The 20,000 observations already made by Münsterberg are distributed in groups of from 400 to 800 among 36 variations of condition. The apparatus used was simple and convenient; the method was a modification of that of average error; the 20 standard distances used ranged from 1 to 20 cm., by differences of 1 cm.; the experimenter worked on himself. The variations included the use of empty spaces and horizontal and vertical lines, seen monocularly and binocularly, with and without motion of the eyes, and in the indirect field, with reproduction at different time intervals after seeing the standard, etc., etc. A bare statement of the final figures in these 36 cases would unduly lengthen this notice; some of the more general conclusions are as follows. The experiments show decidedly that changes of motion, position or use of the eyes produce marked changes in the estimate of distances, to be explained only by the participation of sensations of motion or their memory images; these cannot be given a secondary place in any theory of vision. Empty distances on the right were under-estimated, on the left over-estimated, a fact which the author connects with common practices in reading and writing. The eyes when used separately each over-estimated extensions on its own side. Extensions reproduced after an interval were generally over-estimated, especially the smaller ones; the reproduction was much more accurate if the reproduced lengths occupied exactly the same position as the original. Lines did not seem greater than equal empty spaces, a seeming contradiction of the commonly recognized illusion which Münsterberg, however, explains. Broken lines seemed as usual too long. Lines, unlike empty spaces, were reproduced smaller in both halves of the field, because, as it seems, the eye does not traverse the whole of the standard line, judging partly by indirect vision, and does traverse the whole of the line reproduced, thus giving the latter more sensation of muscular effort. Münsterberg finds the commonly accepted over-estimation of vertical distances only on three conditions, namely, when the distances are empty, the vertical is above the horizontal with which it is compared, and the eyes are free to move. Distances above the horizontal seem longer than equal distances below, if both are of considerable length. Turning from the constant to the variable error, the true measure of the differential threshold, the experiments show it much greater when the eyes are fixed, the difference being due to the fact that in the first case the judgment is based on motions actually executed and in the second on the remembrance of such motions. The variable error is increased or diminished by one and another of the conditions examined; but, other things being equal, Weber's Law holds with a reasonable exactness for the distances experimented upon. What it really applies to, however, is not the estimation of visual extensity, but to the changes of intensity in the motor sensations of the eye.

Raumsinn des Ohres. MÜNSTERBERG. *Ibid.*

The author's theory of the auditory perception of space, arrived at in the original after an examination of previous experiments on sound-localization, and on the functions of the semicircular canals, is briefly this. Sounds differ according to the direction from which they come, independently of changes in quality, intensity, etc., in the disturbance which they produce in the semicircular canals. With these differ-

ent disturbances are reflexly connected the movements necessary to bring the point, from which the sound comes, into the median plane of the head where hearing is most distinct and the cause of the sound may be best investigated by other senses. By a synthesis of the motor sensations thus produced, or their memory images (not necessarily conscious), with the auditory sensations, similar to the synthesis affirmed by the genetic theory in the case of sight and touch, an auditory space arises. Münsterberg's own experiments only remotely touch the question of the organ by which these variations of sound are mediated, and in our opinion he would have greatly improved his paper, as he certainly would have shortened it, by giving a very subordinate place to this whole phase of the question. The immediate point of his experiments was to determine the least observable change in the direction of a given sound. Most of the experiments were made at different points on the circumference of three circles about the head, one lying in the horizontal plane passing through the line connecting the ear-drums, one in the vertical plane passing through the same line, and one in the median plane of the head; the radius of these circles was 1 meter. The stimulus was the clicking of the head of a stem-winding watch, and was given three times at a chosen point (16 equi-distant points were tested in each circumference), then after a second's interval three times again at a slightly different point till the just observable change was determined. The general results were as follows. In the horizontal circle the point of greatest exactness was immediately in front where a change of less than 1° was recognized; the sensibility declined continuously to the point of least exactness immediately behind the head where the least change was nearly 6° . On the frontal-vertical circle the points of greatest exactness were directly opposite each ear, and directly above and below the centre points of the head. On the median circle the point of greatest exactness was 45° below the horizon (and horizontal changes also were here recognized with great exactness), thus coinciding with the point of vision when the eyes are, as commonly, somewhat depressed. Other points of maximal exactness were directly over the head and directly behind it. When one ear was stopped and tests again made in the horizontal circle the exactness was decreased not only on that side, but also on that of the open ear, showing that normally both ears co-operate in localization. When the outer ear was covered inside and out with wax, the sensibility to changes in front was decreased, but for changes in the rear was uninfluenced. The connection of the results with the theory is simplest in the case of the horizontal circle, though the author traces it in all. There the sensibility to change falls off as the muscular tension required to bring the place of sound into the median plane becomes greater; no change of place is perceived unless sufficient to produce a perceptible change in muscular tension. If the discrimination depends on the sensations of muscular contraction, it should follow Weber's Law; and, though no exact quantity can be assigned to the increasing tension, there is a striking correspondence.

Ueber Contrasterscheinungen in Folge von Einstellung; Eine vorläufige Mittheilung. Dr. F. SCHUMANN. Nachrichten v. der k. Ges. d. Wiss. und der Georg-Augusts Universität zu Göttingen. Dec. 3, 1889. No. 20. pp. 5.

In the course of a research upon memory after the general method of Ebbinghaus (now going on at Göttingen), Dr. Schumann noticed certain illusions of contrast, which he has interestingly described and brought into relation with similar effects in other fields of sensation. Nonsense syllables are cut out, fastened to a strip of paper, and rotated on a drum; they are viewed through a slit in a screen allowing just one syllable to be seen at a time. A normal rate of rotation is chosen, so that the syllab-